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AGGREGATE IMPORT DEMAND FUNCTION FOR PAKISTAN: A CO-INTEGRATION APPROACH

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ABSTRACT

This paper examines the determinants of aggregate import demand for Pakistan for the period 1972-1999. The Johansen (1988) co-integration analysis is used for establishing a long run relationship between real imports and its determinants namely real GDP, relative prices and exchange rate volatility. The error correction model is used to capture possible short run disequilbrium. This study provides evidence of a unique long run import demand function. This is further supported by analyzing impulse response function and variance decomposition.

1. INTRODUCTION

The empirical literature lacks studies on import demand determinants for developing countries as indicated by Gafar (1988), Sarmad (1989) etc. This paper provides an evidence of import function for Pakistan. This work differs from other studies for Pakistan in that no study has yet emerged that exploits the time series econometric techniques of co-integration, error correction, vector autoregression, impulse response function and variance decomposition analysis. Additionally, since real imports and its major determinants such as real output, relative prices and exchange rate volatility are non stationary, any evidence without considering the co-integration of the variables leads to inappropriate use of classical t and F-tests, as explained in Granger and Newbold (1974), Fuller (1985), Dickey and Fuller (1979,1981), Engle and Granger (1987), Phillips and Perron (1988), Johansen (1988,1991) and Johansen and Juselius (1990). Presence of non-stationary variables in time series regression leads to (i) non- normal coefficient distribution (ii) spurious regression problem (iii) inconsistent and inefficient ordinary least square estimates of parameters (iv) Invalid error correction representation.

Gafar(1998) specified import as function of real income (real GDP) and relative prices(ratio of import prices to CPI) for the period 1967-84 for Trinidad and Tobago. Results show that income elasticity is more than one and price elasticity is less than one but has a positive sign. Sarmad (1989) specified import as function of real income (real GNP) relative prices (ratio of import prices to whole sale price index adjusted for level of terriff) and foreign exchange reserves for Pakistan for the period 1959-86. The function was estimated in both aggregated and disaggregated form. The study indicates that income elasticity lies between -1.537 to 1.419 and relative price elasticity lies between -1.146 to -1.20.

Following this introduction the paper is organized as follows. Section 2 provides theoretical foundation and modeling of import function. Variable definition and data source appear in section 3. Section 4 furnishes empirical analysis and section 5 concludes.

2. THE MODEL

Using parameter notation from Johansen and Juselius (1990), a vector autoregression model of order k is specified as

$$Y_t = \mu + \pi_1 Y_{t-1} + ... + \pi_k Y_{t-k} + \phi X_t + \varepsilon_t \quad t = 1,2.....,T \tag{2.1}$$

Where Y_t is a p dimensional vector of endogenous variables. X_t is a vector of exogenous variables, ε_t is the usual error correction term such that ε_t ~NID(0,Σ). $\pi_1, \pi_2, ..., \pi_k$ are p×p matrices of parameters that contain the coefficients of endogenous variables. ϕ contains coefficient of exogenous variables and μ is vector of constants. Due to non-stationarity of most economic time series, the VAR in (2.1) is expressed in first difference form with an error correction term to save valuable long run information as:

$$\Delta Y_t = \Gamma_1 \Delta Y_{t-1} + ... + \Gamma_{k-1} \Delta Y_{t-k+1} + \pi y_{t-k} + \phi X_t + \varepsilon_t \tag{2.2}$$

Where

$$\Gamma_i = -(I - \pi_1 - \pi_2 - .... - \pi_i), \quad i = 1,2..., k-1$$

$$\pi = -(I - \pi_1 - \pi_2 - ...... - \pi_k) \tag{2.3}$$

The Johansen co-integration method consists of testing the rank of π to establish the number of co-integrating vectors. Following three possible cases may arise

(I) Rank of π = 0, i.e. π is a null matix. In this case traditional methods of regression on first difference VAR are appropriate and no error correction representation is required.

(II) Rank of π = p i.e. π is full rank matrix, in this case a VAR in level is suitable since each y_t is stationary at level.

(III) Rank of $\pi = r <$ p i.e. π is not a full rank matrix. In this case the coefficient matrix can be written as

$$\pi = \alpha\beta'$$

Where α and β are each matrices of dimension P × r. The eigenvalues λ_i (i=1,2,....p) of the matrix π are computed and the test statistics developed by Johansen (1988) is used.

$$\lambda\text{-Trace(r)} = -T \sum_{i=r+1}^{p} \log(1 - \lambda_i) \tag{2.4}$$

This statistic is to test the hypothesis that there are at most r co-integrating vectors against the alternative that the number is more than r.
Another test statistic:

$$\lambda - Max(r, r+1) = -T \log(1 - \lambda_{r+1}) \tag{2.5}$$

This is used to test the hypothesis that there are r co-integrating vectors against the alternative that they are r+1. The critical values of the tests are provided in Osterwald and Lenum (1992).

In our case, the vector Y_t consists of real imports and its determinants i.e.
$Y_t = (M,G,RP,V)'$. Where M is real import, G is real output, RP is relative price and V is exchange rate volatility, which in this case, is constructed as a four year moving standard deviation as:

$$V = \sqrt{\sum_{i=0}^{3} (R_{t-i} - \hat{R}_{t-i})^2 / 4} \qquad (2.6)$$

Where R_t is nominal exchange rate (Rupees/dollar) and $\hat{R}_t$ is its fitted value obtained using ARIMA model.
In functional form the import demand function is specified as
M = f(G, RP, V)

This model is consistent with Arize and Shwiff(1998) for G-7 countries. They specified import as function of real GDP, relative prices(ratio of unit value index of import to CPI) and exchange rate volatility. The normalized co-integration vectors shows that income elasticity is more than unity, price elasticity is negative and less than one and coefficient of exchange rate volatility is also negative and less than one in magnitude.

Pakistan adopted managed float exchange rate system in 1982, earlier exchange rates were pegged so a dummy variable (DUM) was used as an exogenous variable to capture this change but subsequently it was dropped since it came out to be insignificant.

Economic theory asserts that the sign of the partial derivatives are as follows:

$$\frac{\partial f}{\partial G} > 0, \quad \frac{\partial f}{\partial RP} < 0, \quad \frac{\partial f}{\partial V} < 0$$

A log linear function form is specified since it is backed by considerable empirical support e.g. Sarmad (1988,89), Khan and Ross (1977).

3. THE DATA

All variables except V are expressed in natural logarithms. The data on all variables is collected from various issues of International Financial Statistics. M is obtained by deflating nominal imports(million rupees) by unit value index of import, G is constructed by deflating nominal GDP (billion rupees) by GDP deflator at base 1995. RP is obtained by dividing unit value index of imports by GDP deflator and V is a four year moving standard deviation.

This type of measure has been used by many authors including Akhter and Hilton (1984), Koray and Lastrapes (1989), Chowdhury (1993), Arize and Shwiff (1998) among others. Kumar and Dhawan (1991) have used volatility variabe in studying export function for Pakistan. We have used GDP deflator to capture domestic prices since it has a wider coverage than CPI and WPI which might exclude goods that are potentially very important for Pakistan that are among major imports (e.g. machinery, chemicals etc).

4. EMPIRICAL ANALYSIS

The first step in any co-integrating analysis is to test the stationarity properties of the series under consideration. Table 1 presents the Augmented Dickey Fuller test which assumes non stationarity under null hypothesis. The table indicates that all variables are found non-stationary at level and stationary at first difference. A plot of the series (available on request) indicates no structural break, so more sophisticated unit root tests are not consulted. Next the order of vector autoregression is determined. Likelihood ratio test has been used starting with four lags and sequentially testing down to finally choosing VAR (1) as the appropriate one. For testing the number of cointegrating vectors using Johansen co-integration method table 2 provides λ-max and λ-trace statistics and 95% critical values.

Both of the test statistics strongly support the hypothesis of one co-integrating vector. This co-integrating vector, normalized for real imports is given as

$$M = 0.996G - 1.659RP - 0.306V - 1.547 \qquad (4.1)$$

This normalized equation agrees with economic theory and prior expectation of signs. Real import is nearly unit elastic with respect to real output, relative price is elastic and exchange rate volatility is inelastic. Thus it appears that import grows proportionally with real income. The relative price elasticity is higher than estimated earlier by Sarmad (1989) which indicates that Pakistan's competitive position in international trade has improved. But again this cannot be strictly compared since earlier studies have not considered the co-integration of the variables. The earlier studies therefore might suffer from what is indicated in section II.

Table-I: Augmented Dickey Fuller Test Statictic

Variables	Level	First Difference
M	-2.004	-3.383*
G	-1.358	-5.905**
RP	-2.58	-3.575**
V	-2.528	-4.205*

* Significance at 1%level   ** Sinificance at 5% level

Table-II: Testing The Rank of matrix π

	λ-Max				λ-Trace			
λ	Ho	H1	Stats	95%	Ho	H1	Stats	95%
0.6094	r = 0	r = 1	23.507	23.80	r = 0	r = 1	51.712	47.21
0.5061	r ≤ 1	r = 2	17.640	17.89	r ≤ 1	r = 2	28.205	29.68
0.3110	r ≤ 2	r = 3	9.313	11.44	r ≤ 2	r = 3	10.565	15.41
0.0488	r ≤ 3	r = 4	1.252	3.84	r ≤ 3	r = 4	1.252	3.76

Note: Trace statistics clearly indicates presence of one co-integrating vector

There has been some consideration in literature about validity of aggregate elasticities see for example Barker (1970), Orcutt (1950). But Grunfeld and Grilich (1960), Leamer and Stern(1970) and

Aigner and Goldfeld (1973) provided some evidence that dis-aggregate data may be subject to measurement error than aggreagate data and the predictions obtained from dis-aggregated models may not be better than those obtained from an aggregate model.

4.1 Impulse response function

To investigate further the relationship between imports and its determinants, another tool is impulse response function. This shows how each endogenous variable responds to shock in other variable. That is the Impulse response function traces the response of the endogenous variable to one standard deviation shock in each variable in the system. This is displayed graphically in figure 1.

Figure 1 trace the response of innovation in each variable on real imports. The highest negative impact over time that is increasing gradually is of real relative prices. While a shock in output and volatility have little effect on the equilibrium value of import. A shock in import in previous periods will have its positive effect, which is gradually increasing.

4.2 Variance Decomposition

Another way of characterizing the dynamic behavior of the model is through variance decomposition. This breaks down the variance of the forecast error from each variable into components that can be attributed to each of the endogenous variable. Table III shows the variance decomposition of each variable. The first column indicates forecast horizon. The second column shows percentage of real imports forecast error variance that can be attributed to real import itself. Similarly 3rd, 4th and 5th columns show the percentage of real import forecast variance that can be attributed to real output, relative prices and exchange rate volatility, respectively.

For example panel (a) shows that the most significant effect on imports is of relative prices that is gradually increasing reaching 38% in tenth year. Output and volatility have relatively smaller. Panel (b) shows that initially imports have some effect on output but its role is gradually decreasing. In the longer horizon relative prices and volatility becoming important for explaining variance in output. Panel (c) shows that after 5 period 38% variance in relative prices is due to import which is slowly decreasing. Panel (d) shows that the variables in the system have little effect of volatility. This confirms our similar observation from the causality test.

Fig. 1: Response of Import to Shocks in Different Variables

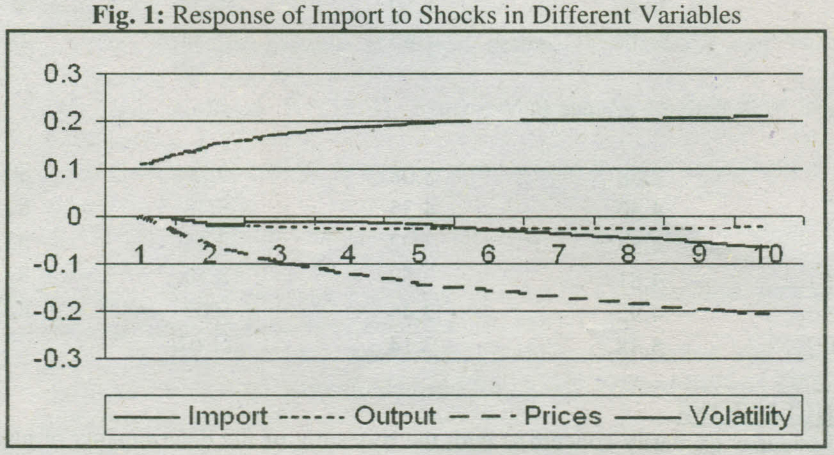

Table-III: Decomposition Of Forecast Error Variance

Percentage Of forecast variance explained by shocks in:

	M	G	RP	V
Year	Relative Variance In M			
1	100.00	0.00	0.00	0.00
2	90.32	0.63	8.35	0.70
3	82.40	0.92	16.12	0.57
4	76.91	1.05	21.52	0.52
5	72.80	1.09	25.53	0.58
10	59.13	0.90	37.79	2.18
Year	Relative Variance In G			
1	9.86	90.14	0.00	0.00
2	3.26	48.92	1.47	46.36
3	1.40	33.73	9.38	55.48
4	0.69	23.00	16.72	59.58
5	0.42	16.82	23.32	59.44
10	0.33	5.86	40.99	52.82
Year	Relative Variance In RP			
1	45.52	0.00	54.48	0.00
2	41.36	1.19	57.45	0.00
3	40.14	1.33	58.32	0.22
4	39.28	1.46	58.97	0.29
5	38.63	1.50	59.54	0.33
10	36.06	1.45	62.31	0.18
Year	Relative Variance In V			
1	2.58	8.08	9.26	80.08
2	4.30	4.35	8.48	82.86
3	4.57	3.92	8.43	83.08
4	4.81	3.59	8.70	82.90
5	4.95	3.45	9.07	82.53
10	5.48	3.14	11.61	79.78

5. CONCLUSIONS

This paper is primarily concerned with the re-testing of the determinants of aggregate import demand function for Pakistan using time series techniques of cointegaration and error correction.

There appears to be a single co-integration vector which asserts that real import is nearly unit elastic with respect to real output, relative price is unit elastic and exchange rate volatility is inelastic. Proportional growth of import with output has led some researchers (e.g. Milas (1998) in case of Greece) to suggest that, to improve balance of trade, output growth should be restricted in some way for example by increasing taxes. We optimistically suggest not to constrained or hinder output growth. The elastic relative prices is seen to favor devaluation to reduce imports and improve trade balance. Since Pakistan's import mainly consist of items that are conducive to growth in output, devaluation cannot be recommended. This leaves export promotion as a viable option to improve trade balance.

REFERENCES

1. Aigner, D.J. and Goldfeld, S.M. (1973). Simulation and Aggregation: a reconsideration. *Review of Economics and Statistics*, 55, 114-118.
2. Akhter, M. and Hilton, R.S. (1984). Effects of exchange rate uncertainty on German and U.S. trade. Federal Reserve Bank of New York Quarterly Review, Spring, 7-16. error-correction models. *Review of Economics and Statistics*, LXXV(4), 700,706.
3. Ariz, A.C. and Shwiff, S.S.(1998). Does exchange rate volatility affects trade flows in G-7 countries? evidence from Co-integration model. *Applied Economics*, 30, 1269-1276.
4. Barker (1970). Aggregation error and estimation of U.K. import demand function. in the econometric study of United Kingdom. Ed. K. Hilton and D.E. Heathfeld, Macmillan, London.
5. Chowdhry, A.R. (1993). Does exchange rate volatility depress trade flows? evidence from error –correction models. *Review of Economics and Statistics*, LXXV(4),700-706.
6. Dickey, D.A. and Fuller, W.A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal Of American Statistical Association*, 74, 427-433.
7. Dickey, D.A. and Fuller, W.A. (1981). Likelihood Ratio Statistics for autoregressive time series with a unit root. *Econometrica,* 49, 1057-1072.
8. Enders, W. (1995). Applied Econometric Time Series. John Wiley, New York.
9. Engle, R.F and Granger C.W.J. (1987). Co-integration and error correction: representation, estimation and testing. *Econometrica,* 55, 251-276.
10. Fuller, W.A. (1985). Non-stationary autoregressive time series in E.J. Hannan et al Handbook of Statistics 5.
11. Gafar, J.S. (1988). The determinants of import demand in Trinidad and Tobago. *Applied Economics,* 20, 303-313.
12. Granger, C.W.J and Newbold, P. (1974). Spurious regression in Econometrics. *Journal Of* Economtrics, 2, 111-120.
13. Grunfeld, Y and Griliches, Z.(1960). Is aggregation necessarily bad? *Review Of Economics and Statistics*, 42, 1-13.
14. Johansen, S. (1988). Statistical Analysis of co-integrating vectors. *Journal Of Economic Dynamics And Control*, 12, 231-254.
15. Johansen, S. (1991). Estimation and hypothesis testing of Co-interation vectors in Gaussian autoregressive models. *Econometrica*, 59, 1551-1580.
16. Johansen, S and Juselius, K.(1990). Maximum Likelihood estimation and inference in Co-integration with application to demand for money. *Oxford Bulletin Of Economics and Statistics*, 52,169-210.
17. Khan, M.S. and Ross. K.Z. (1979). The functional form of the aggregate import demand equation. *Journal Of International Economics*, 7, 149-160.